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10/618,155	07/11/2003	Jaime Poris	NAN068 US	4143

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EXAMINER	
KIELIN, ERIK J	
ART UNIT	**PAPER NUMBER**
2813	

DATE MAILED: 04/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/618,155	PORIS, JAIME
	Examiner	**Art Unit**
	Erik Kielin	2813

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on *15 December 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) *6,8 and 11-19* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-5,7,9 and 10* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *11 July 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/11/03 5/14/04 11/23/04*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of the invention of Group I, claims 1-10 and the species A-2, with claim 7 indicated by Applicant to read thereon, in the reply filed on 15 December 2004 is acknowledged.

2. Claims 11-19 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim.

3. Claims 6 and 8 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected species, there being no allowable generic or linking claim.

Claim Objections

4. Claim 10 is objected to because of the following informalities: in the last line, remove "and film" for clarity. Appropriate correction is required.

Claim Rejections - 35 USC § 112

5. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

6. Claim 3 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 3 recites the limitations, "wherein determining the mass of the film material deposited on the substrate comprises: taking a coulometer measurement **during** the deposition of

the film on the substrate; and using the coulometer measurement to determine the mass of the film material." (Emphasis added.)

If the measurement is taken "during" --rather than after-- the deposition of the film, all of the film will not yet have been deposited; therefore, the mass determination will necessarily be inaccurate and the all subsequent calculations using the measurement will be inaccurate.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

8. Claims 1, 4, 5, and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,698,989 (**Nulman**) in view of Applicant's admitted prior art (**APA**) and The Penguin Dictionary of Electronics, 3rd ed, Penguin Books: London, 1998, pp. 486 and 513 (**Dictionary**, hereafter).

Regarding claim 1, **Nulman** discloses a method comprising:

depositing a film on a substrate **24** (paragraph bridging cols. 2-3);

measuring the resistance/sheet resistance the film at a plurality of locations using an eddy current measurement (col. 1, lines 41-57; col. 5, lines 4-16);

determining the thickness the plurality of locations using the determined sheet resistance of the film at the location (col. 1, lines 41-57; col. 5, lines 4-16; col. 6, lines 30-42).

Nulman does not indicate the manner in which the average resistivity is determined, or the relationship between the sheet resistance and the film thickness. **Nulman** does, however, state at col. 1, lines 43-45, "The bulk resistance [i.e. resistivity] of any desired material composition **can be determined experimentally**..." (emphasis added).

APA states in the last paragraph of page 1,

> "An eddy current sensor is commonly used to measure the thin film sheet resistance associated with conductive samples. While the standard eddy current sensor cannot measure the actual film thickness, the measured sheet resistance can be converted into film thickness **with knowledge of the resistivity** of the material." (Emphasis added.)

With this in mind, **APA** states that it is known in the art to use the eddy current probe to measure the sheet resistance, to determine the resistivity of the thin film, and finally to determine the thin film thicknesses from the sheet resistance measurements and the resistivity.

The **Dictionary** defines **sheet resistance**, R_s, on p. 513, as "The resistance of a unit square of a thin-film material, such as a metal or thin layer of semiconductor, defined as $R_s = \rho /t$ where R_s is the sheet resistance, ρ the resistivity, and t the thickness... R_s has dimensions of resistance but is commonly given the unit 'ohms per square'." The **Dictionary** defines **resistivity**, ρ, on p. 486, as "An intrinsic property of a material equal to the resistance per metre of material with cross-sectional area of one square meter..."

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to use the eddy current probe measurements of the sheet resistance at the plurality of locations in **Nulman** to **determine the average sheet resistance**, to **determine the average resistivity of the thin film**, and finally **to calculate the thin film thicknesses from the sheet**

resistance measurements and the average resistivity, as expressly suggested by **APA** to be known in the art.

Also, it would have been obvious for one of ordinary skill in the art, at the time of the invention to **determine the average thickness of the conductive thin film** and the **average sheet resistance** in **Nulman** in order to determine the average resistivity, ρ, because the **Dictionary** teaches that the average thickness, t, is required to calculate the resistivity, ρ, according to the relationship $R_s = \rho / t$, or by rearranging $\rho = R_s t$, and because **APA** teaches that "knowledge of the resistivity," ρ, is required for calculation of the film thickness at any given location where an eddy current probe measurement of sheet resistance of the thin conductive film is made. In other words one of ordinary skill knows exceedingly well that the basic equations relating the eddy current measurements to film thickness dictate those pieces of data of the thin film which must be collected, i.e. Rs, ρ, and t.

Regarding claim 4, it is seen to be inherent that the use of the eddy current probe in **Nulman** requires inducing an eddy current in the film deposited over the substrate and monitoring an electrical response modified by the induced eddy current to determine the resistance, as sheet resistance, as admitted by Applicant in the instant specification

Regarding claim 5, the method of Claim 1, further comprising placing the substrate in contact with a thermal heat sink to control the temperature of the substrate **24** in order to get more accurate measurement of sheet resistance and film thickness (col. 3, lines 21-26; col. 5, lines 4-16).

Regarding claim 7, **Nulman** discloses that temperature control to below 100 °C is essential for more accurate measurement of sheet resistance (col. 3, lines 21-36). **Nulman** also

indicates that a feedback from a thermocouple **40** may be used to control the "operation of the sheet resistance probe **36** [eddy current sensor]."

Nulman does not indicate that repeated resistance measurements of the film are made at a first location until the difference between the last two measurements are below a threshold before measuring the resistance of the film at the remaining locations, as a specific method of determining the stability of the measurement.

However, it would have been entirely obvious for one of ordinary skill in the art, at the time of the invention to make repeated resistance measurements using the eddy current probe of the film at a first location until the difference between the last two measurements are below a threshold, before measuring the resistance of the film at the remaining locations, in order to obtain an accurate sheet resistance measurements, as suggested by **Nulman**. **Nulman** states that the substrate temperature affects the accuracy of the eddy current probe measurements and stability of the temperature would necessarily be dictated by the measurement of the sheet resistance at a single location which does not vary with time beyond the random noise generated by the probe itself in a given environment, (i.e. the threshold).

9. Claims 1 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent Application Publication 2002/0070126 A1 (**Sato** et al.) in view of Applicant's admitted prior art (**APA**) and <u>The Penguin Dictionary of Electronics</u>, 3rd ed, Penguin Books: London, 1998, pp. 486 and 513 (**Dictionary**, hereafter).

Regarding claim 1, **Sato** discloses a method comprising:

depositing a copper film on a substrate using electroplating (paragraph [0027]);

determining the thickness of the copper film at a plurality of locations by inherently measuring at least one of the resistance and conductance of the film at a plurality of locations using an eddy current probe (paragraph [0230]; Fig. 6A), as admitted by **APA**, since eddy current probes necessarily respond to resistance changes associated with a conductive thin film and thereby measure sheet resistance (**APA**, instant specification at p. 1, last paragraph).

Sato does not indicate the measurements and calculations associated with the eddy current probe measurements that are used to determine the thickness of the copper film at the plurality of locations.

APA states in the last paragraph of page 1,

> "An eddy current sensor is commonly used to measure the thin film sheet resistance associated with conductive samples. While the standard eddy current sensor cannot measure the actual film thickness, the measured sheet resistance can be converted into film thickness with knowledge of the resistivity of the material." (Emphasis added.)

With this in mind, **APA** states that it is known in the art to use the eddy current probe to measure the sheet resistance, to determine the resistivity of the thin film, and finally to determine the thin film thicknesses from the sheet resistance measurements and the resistivity.

APA states in the last paragraph of page 1,

> "An eddy current sensor is commonly used to measure the thin film sheet resistance associated with conductive samples. While the standard eddy current sensor cannot measure the actual film thickness, the measured sheet resistance can be converted into film thickness **with knowledge of the resistivity** of the material." (Emphasis added.)

With this in mind, **APA** states that it is known in the art to use the eddy current probe to measure the sheet resistance, to determine the resistivity of the thin film, and finally to determine the thin film thicknesses from the sheet resistance measurements and the resistivity.

The **Dictionary** defines **sheet resistance,** R_s, on p. 513, as "The resistance of a unit square of a thin-film material, such as a metal or thin layer of semiconductor, defined as $R_s = \rho /t$ where R_s is the sheet resistance, ρ the resistivity, and t the thickness... R_s has dimensions of resistance but is commonly given the unit 'ohms per square'." The **Dictionary** defines **resistivity**, ρ, on p. 486, as "An intrinsic property of a material equal to the resistance per metre of material with cross-sectional area of one square meter..."

Accordingly, it would have been obvious for one of ordinary skill in the art, at the time of the invention to use the eddy current probe measurements (inherently measuring the sheet resistance, as admitted by **APA**) at each of the plurality of locations in **Sato** to **determine the average sheet resistance**, to **determine the average resistivity of the thin film**, and finally **to calculate the thin film thicknesses from the sheet resistance measurements and the average resistivity**, as expressly suggested by **APA** to be known in the art.

Also, it would have been obvious for one of ordinary skill in the art, at the time of the invention to **determine the average thickness of the copper film** and the **average sheet resistance** in **Sato** in order to determine the average resistivity, ρ, because the **Dictionary** teaches that the average thickness, t, is required to calculate the resistivity, ρ, according to the relationship $R_s = \rho /t$, or by rearranging $\rho = R_s t$, and because **APA** teaches that "knowledge of the resistivity," ρ, is required for calculation of the film thickness at any given location where an eddy current probe measurement of sheet resistance of the thin conductive film is made. In other words one of ordinary skill knows exceedingly well that the basic equations relating the eddy current measurements to film thickness dictate those pieces of data of the thin film which must be collected, i.e. Rs, ρ, and t.

Regarding claim 4, it is seen to be inherent that the use of the eddy current probe in **Sato** requires inducing an eddy current in the film deposited over the substrate and monitoring an electrical response modified by the induced eddy current to determine the resistance, as sheet resistance, as admitted by Applicant in the instant specification

10. Claims 2 and 3 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Sato** in view of **APA** and the **Dictionary** as applied to claim 1 above, and further in view of US 6,790,331 B2 (**Katsumaru** et al.).

The prior art of **Sato** in view of **APA** and the **Dictionary**, as explained above, discloses each of the claimed features except for the method by which the average film thickness is determined.

Katsumara, like **Sato**, uses electroplating to deposit thin metal films on a substrate and uses an coulometric measurement to determine the average film thickness including

depositing the film on the substrate;

determining the mass of the film material deposited on the substrate, wherein determining the mass of the film material deposited on the substrate comprises:

taking a coulometer measurement during the deposition of the film on the substrate; and

using the coulometer measurement to determine the mass of the film material (Col. 7, Table 1) --as further limited by instant claim 3;

determining the film density of the film (col. 8, lines 37-40);

determining the surface area over which the film is deposited (col. 8, lines 45-47); and

calculating the average thickness using the mass of the film material, the film density, and the surface area (col. 8, lines 33-51 and Table 2).

11. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Sato** in view of **APA** and the **Dictionary** as applied to claim 1 above, and further in view of US 4,084,136 (**Libby** et al.).

The prior art of **Sato** in view of **APA** and the **Dictionary**, as explained above, discloses each of the claimed features except for producing an eddy current in the film is performed at multiple excitation frequencies.

Libby teaches that it has long been known in the art to use either single or multiple excitation frequencies for producing an eddy current in a thin film to determine the thin film resistance (col. 1, lines 14-41).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use either single or multiple excitation frequencies to produce the eddy current as a matter of design choice, as proven by Libby, since it appears that either would work just as well and because both are known and because Sato is silent as to whether the probe uses single or multiple excitation frequencies, such that one of ordinary skill would be motivated to use those known to give the desired results for a given application. Moreover, the exists no evidence of record that multiple excitation frequencies would work better than single and even if there were, multiple excitation frequencies are separately known to have benefits.

12. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Sato** in view of **APA** and the **Dictionary** as applied to claim 1 above, and further in view of SU 1613847 A (**Mikhin**).

The prior art of **Sato** in view of **APA** and the **Dictionary**, as explained above, discloses each of the claimed features except for

measuring at least one of the resistance and conductance of the substrate at the plurality of locations prior to depositing the film on the substrate;

determining the resistance or conductance of the film using the measured at least one of the resistance and conductance of the substrate and the measured at least one of the total resistance and total conductance of the film.

Mikhin teaches the use of eddy current measurements of the substrate (called "base") before and after coating to determine the film thickness.

It would have been obvious for one of ordinary skill in the art, at the time of the invention to measure at least one of the resistance and conductance of the substrate at the plurality of locations prior to depositing the film on the substrate; and determining the resistance or conductance of the film using the measured at least one of the resistance and conductance of the substrate and the measured at least one of the total resistance and total conductance of the film, because **Sato** is silent to the method by which the eddy current measurements are massaged to determine the film thickness such that one of ordinary skill would be motivated to use known methods capable of yielding the thickness, as desired in **Sato**, and as taught to be known to do in **Mikhin**.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached from 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Erik Kielin
Primary Examiner
April 5, 2005